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## CONTENTS:

<i>The Last Quarter—A Reminiscence and an Outlook:</i>	
PROFESSOR LUCIEN M. UNDERWOOD.....	161
<i>Artificial Parthenogenesis in Annelids:</i> PROFESSOR JACQUES LOEB.....	170
<i>The Astronomical and Astrophysical Society of America (II):</i> PROFESSOR GEO. C. COMSTOCK.....	171
<i>Scientific Books:—</i>	
<i>Loew's Investigations on Tobacco:</i> DR. H. N. STOKES. <i>Cory on the Land Birds of Eastern North America:</i> W. H. OSGOOD.....	191
<i>Scientific Journals and Articles.....</i>	192
<i>Discussion and Correspondence:—</i>	
<i>Kite vs. Balloon: A LAWRENCE ROTCH. Callosities on Horses' Legs:</i> DR. W J MCGEE.....	193
<i>Notes on Inorganic Chemistry:</i> J. L. H.....	194
<i>Medical Exhibits at Paris.....</i>	195
<i>Sigma Xi, The American Association and The Geological Society of America.....</i>	196
<i>Scientific Notes and News.....</i>	197
<i>University and Educational News.....</i>	200

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## THE LAST QUARTER—A REMINISCENCE AND AN OUTLOOK.\*

NINETY years ago, a botanist holding a professor's chair in Williams College for the supposed mismanagement of an estate in Columbia county was confined for a short period in a debtor's prison in New

York City. Years afterward he related to a friend that as a relief to the monotony of confinement he found amusement in teaching botany to the keeper's son whom he described as a bright youth of fourteen years. From such an inauspicious beginning came the real development of botany in this city, for while Hosack had attempted to develop his Elgin Gardens earlier in the century, the above episode was the beginning of a career that resulted in the rapid advance of botanical science in New York. It is only proper to add that the professor above noted was no less a personage than Amos Eaton, author of the first series of American botanical manuals, and the willing pupil was none other than John Torrey, the Nestor of American Botany.

Were we tracing the full pedigree of botany in New York, it would be necessary to follow the record two generations back of Torrey, for it was Hosack, the originator of the first botanic garden of New York who instructed and assisted Amos Eaton in his early botanical studies while the latter was still a law student in New York City, and more specially after he had passed on to his higher work of instruction. Hosack's Botanical Garden at 54th Street and Madison Ave. was too far out of town for the New Yorkers of 1801–1806 to visit, and it passed over finally to Columbia College and laid a solid foundation for the financial endowment of that institution, as property

\* Address of Retiring President, Botanical Society of America.

advancement followed settlement northward up Manhattan Island. It was little wonder that this college early came to foster botanical science and later accumulated the foundations that have led up to its present tender of facilities for botanical research along varied lines.

It is unnecessary in this presence to relate in detail the incidents which led up to the development of a botanical center here as early as 1831, so that Asa Gray, restive in his work in Central New York and casting about for a place where he could study botany, could find no better tutelage than under his master Torrey, and came to New York as Torrey's pupil and finally became his assistant in the preparation of the *Flora of North America*, a work that will ever stand as a masterpiece in American botany, combining with the critical acumen and exact learning of its senior author the enthusiasm and push of its more youthful one. It may, however, be useful at this time to call to mind some of the conditions existing at the time of the first appearance of Torrey and Gray's *Flora* in 1838 or even at the period of the issue of the final part of the second uncompleted volume in 1843. The great Louisiana Purchase of 1803 extending northwestward from the mouth of the Mississippi to the Pacific had scarcely been entered by the scientific explorer except in its Northern portion, and that mainly by Lewis and Clark in their discovery of the headwaters of the Columbia and by Long's expedition to the Rocky Mountains. Texas and the great Southwest, Utah, Nevada, and California were quiet, Mexico-Spanish possessions alike undisturbed by the hum of civilization or the visitation of the field botanist except as some wandering explorer like Adelbert Chamisso had touched at the Pacific ports and had skimmed a few memorials of the vast west coast flora, or some Russian expedition had pushed down from their north-

ern possessions into Northern California. Minnesota and the Northwest were still in the hands of the Indians, and all of Iowa and much of Illinois were raw prairie untouched by the plow of the pioneer. Chicago was a hamlet with a handful of people struggling with fever and ague on the wind swept marshes at the lower end of Lake Michigan. The South which even yet has scarcely produced an indigenous botanist was then a region untouched since the travels of Michaux, except as Short and Peter had explored Kentucky and Stephen Elliot, the father of Southern botany, had brought to notice something of the flora of the Carolinas. Such in brief was the state of our country and its botanical exploration when Gray received his call to Cambridge and laid there the foundation of a second center of botanical research. The annexation of Texas as the second of our Spanish acquisitions of territory; the Mexican war with the commencement of our expansion policy in the cession of California and New Mexico with the attendant military occupation and exploration for the settlement of boundaries; the discovery of gold in California in 1848 and the attendant development of that Eldorado of immigration, and finally with the transcontinental railroad projects of the early fifties, all brought to Torrey and Gray the floral wealth of these extensions of territory and have made the Torrey herbarium at New York and the Gray herbarium at Cambridge the two great repositories of the types of western plants, each supplementing the other in their priceless possessions.

Few of the present generation of botanical students realize clearly the rapid advance of their science in the past quarter of a century or the conditions under which the student of botany was placed at the beginning of that period. It is just an even twenty-five years since your retiring president completed the solitary course in bot-

any offered in his undergraduate collegiate work in 1875. It was a course of lectures given by a great and good man, but one whose first love was geology and not botany, and extended through a short term of twelve weeks in which we were instructed in some of the details of the structure of the flowering plants something after the pattern set in Gray's lessons, after which we were directed how to use Gray's Manual for determining the unknown names of such familiar plants as the Trillium, the spring beauty, the wild geranium and the white daisy with all the array of names like *Leucanthemum chrysanthemum* that nearly paralyzed such of the students as had pursued a long course in Greek. There was scarcely a word as to the homology of parts, relationship of plants to each other or to their environment. Not a word was breathed about the world of cryptogamic organisms; the ferns and fungi were alike tabooed, and liverworts and lichens may as well have had a non-existence for we never heard them mentioned, and went out of college ignorant of their existence at least from any direct information from the instructor. The compound microscope was sealed to us except as an illustration of the application of the principles of optics, but we well remember the half day of unalloyed pleasure when we stole into the room where it was usually securely locked in its case and for once found the case open. How we reveled in a set of prepared slides and had our first self-taught lesson in plant histology.

This personal reminiscence is not an unusual picture for those times, for then there were in the country only two or three colleges where there was a distinctive professor of botany, and even in these more favored institutions the character of the instruction was much the same as I have pictured. Ecology was unheard of in the schools; plant physiology was scarcely mentioned

and indeed its only printed exponent available was 'How Plants Grow, Gray.' Evolution was some unholy doctrine about monkeys that contradicted the Bible. It was with the force of an electric shock that a short time later the translation of Sachs' Botany opened to our astounded eyes the manner in which we as students had been robbed of the knowledge of the splendid advance of the science that had been in progress in Germany during the middle half of the present century. Soon after this, Bessey's 'Botany' for schools appeared, and it is no exaggeration to say that since the time when Amos Eaton's first class in Williams College begged the privilege to publish for him the first and most famous edition of his manual, no single book has appeared that for its time has proved a more valuable contribution to botanical teaching in America. Bessey's work was particularly useful at this time because it served to introduce the younger student to Sachs' more extensive and difficult text-book and showed him that there were other and broader considerations in botany than the mere 'analysis of flowers,' and gave him for the first time a rational conception of that underworld of plant life of which the hitherto one-sided facilities for study had robbed him. Since that time wave after wave of lines of botanical investigation and methods of teaching have swept over us, and system after system of elementary instruction has been proposed and has been crystallized or more often presented in an amorphous condition in the numerous text-books and laboratory manuals of the past fifteen years.

I should add here that indirectly a second factor greatly stimulated the development of the new botany, namely the introduction of elementary biological study in the schools, for about this time Huxley's 'Biology' appeared and from an English stimulus American students commenced the development of biological investigation from a new stand-

point. Laboratory methods were commenced, and laboratory equipments followed. But Huxley was mainly a zoologist, and thus not unnaturally it came about that some American biologists came to be developed in a one-sided way, and in some cases came to assume the unfortunate proposition that biology was only another name for zoology. In later years they learned their mistake and for the future the student who hopes for success along biological lines recognizes that he is committing a fatal error if he does not prepare for his future with a vigorous foundation in plant biology.

Twenty-five years ago there was practically one American botanist and his manual was supposed to be the end of all necessary knowledge even though its descriptions often failed to cover variations noted that later botanists have dared to call species. In some remote quarters the momentous question was occasionally presented to the teacher of botany, Is Gray's system really better than Wood's? but usually there was little dissent from an affirmative answer to the question.

It was in the latter part of this same year (1875) that the first number of the *Botanical Bulletin* (now the *Botanical Gazette*) was issued by the enthusiastic professor of natural science of a little college in southern Indiana. It was a four-page sheet without cover containing mainly notes on the local flora of the vicinity of the college and bearing little prophecy of its present development into two volumes aggregating nine hundred pages a year. Five years before The Torrey Club of New York had founded its *Bulletin*, but for the five years prior to 1875 had not produced so many pages as have just been issued in the first five months of the year 1900. Something of the aim of the latter journal in its early days may be of interest at this time. We quote from the first number, January, 1870: "An at-

tentive study of plants in their native haunts is essential to the advance of the science, and in this respect the local observer has an advantage over the explorer of extensive regions, or the possessor of a general herbarium. He can note the plant from its cradle to its grave; can watch its struggles for existence, its habits, its migrations, its variations; can study its atmospheric and entomological economies; can speculate on its relations to the past, or experiment on its utility to man. It would be in vain to attempt to enumerate all the points about which a lover of vegetable nature can learn and report something new. Botany, like every other science, far from being exhausted, is ever widening its field." This language for the time in which it was written was an unexpected prophecy, for at this period scarcely anyone looked at botany as a serious subject. It was regarded as a suitable study for misses' boarding schools and a harmless elective in a few of the more enlightened colleges. No facilities were open for advanced work and none was thought of by the college authorities. A botanist to grow must delve for himself, must invent his methods, must acquire unaided the mastery of his implements of research. If, as was usually the case, he was short of means, he must either teach or practice medicine and from his overcrowded hours steal the time in which to devote himself to the object of his love. With most of us it was a literal exemplification of Agassiz' rule that to succeed as a naturalist one must 'lie hard and live low,' and many in the struggle lost their ambition and went in pursuit of more lucrative subjects.

The government, except in now and then detailing a botanist and too often an untrained one on some exploring expedition, had not yet commenced to foster botanical research. There was a botanist, to be sure, to the Department of Agriculture and he did accumulate an extensive collection so long

stored in the old fire trap that, be it said to the disgrace of our Government, still serves to house this Department; and this collection, fortunate in escaping the hazards of fire, formed the nucleus of the splendid national herbarium now housed in the crowded attics of the National Museum.

Such is a faint picture of the conditions of American botany as they existed twenty-five years ago. What American botany has become to-day with its centers of scientific research scattered throughout the country from New England to the Golden Gate, with its botanical publications in a healthful and hopeful if not prosperous state of development, with its agriculture and the arts clearly recognized by the state and general governments, with the work of the experiment stations which in many states have already passed their formative stages and are entering the lists as centres of intelligent botanical research, in the forestry reserves which are already fields of practical experiment and promise also to form similar research centers, and finally in the attitude of men of thought and men of wealth who are devoting their activities of brain and purse toward better making known the importance of the plant world to man in its utility and beauty, and seeking for the advancement of botanical knowledge throughout the earth,—these are the products almost of the past two decades and measure a progress unparalleled in the history of scientific development in any country and in any age. And this progress has commenced along diverse and in some cases unexpected lines. After instruction in botany ceased to be merely the analysis of flowers, came the study of types leading the student to consider other subjects than the flowering side of plant creation opening up new lines in morphology and plant development; then came plant physiology taking inspiration from the labors of Sachs and others across the sea; then fol-

lowed plant cytology from the enthusiasm kindled in the American students who for years have formed the greater number of workers in the famous laboratory at Bonn; later still plant embryology has for the time been the botanical fashion and has opened up new points of view for the study of plant relationship.

To revert once more to Amos Eaton who may be regarded not only as the pioneer of the long succession of botanical teachers in America, but as well the author of the first series of botanical manuals that have made a knowledge of our flora accessible to students, we desire to call attention to what he considered the cardinal preparation for the work of a botanical instructor "No one," said he, "should attempt to give instruction in botany who is not thoroughly familiar with at least four hundred plants." It has been reserved for the present generation to produce botanical teachers who do not know plants and those whose lack of botanical perspective becomes intensified in the successive crops of highly specialized students that come out from their instruction; and we may well emphasize this early principle which in the present generation is even more essential as the first equipment of a genuine botanist than it was in Eaton's time. This leads us naturally to some thoughts and propositions concerning the future of botany in America, and some lines of training necessary to make this future satisfactory. It will be readily admitted that aside from applied botany which has for its work the making known of the plant world for the greater comfort and enjoyment of the human race, one of the highest aims of purely scientific botanical study whether cytological, morphological, or embryological, is to determine the relationship of plants to each other and the establishment of a natural system of classification. This has been the struggle of botanists from the time of Jussieu to the present and every

genuine botanical contribution attacking the problem continually from a new standpoint adds its iota to this desired end. The undergraduate course of botany therefore to attain its best success either as a preparation for life or as a preparation for botanical or biological research should not commence the fad for specialization too early. It ought thoroughly to familiarize the student with the common types of plants not alone in the laboratory and in pickle but in their living freshness in the field. The broadest as well as the most intimate acquaintance with as wide an array as possible is none too much. Besides the four hundred plants of the higher type that Eaton recommended as a minimum, the student of to-day ought to know half as many at least from the array of lower plants which in Eaton's time were a world almost unknown. And all this should be in hand in addition to the best attainable methods of study with the means of using to the best advantage the modern implements of research from the simple lens and the dissecting needles which should not be neglected, to the microtome and the various culture media. Following this, the research course for those who really expect to be botanists, to attain its highest results ought to involve some phase of systematic botany, for otherwise the student confining himself to too narrow lines is still in danger of losing his perspective. I do not mean systematic botany in its old-fashioned narrow sense but in its newer and broader sense in which morphology, embryology, and the widest application of accessory study in culture house, laboratory and field is brought to bear on the solution of a taxonomic problem.

The line of research study that is primarily embryological ought not to be confined to a single type, but should involve the comparative study of the types of a family or in the case of restricted families the relations to outliers in others. If the

major line of research involves the life history of a species among the lower plants, it ought also to involve a comparative study of the allied American species, for no one could be better prepared to monograph a genus than one who from his studies of development understands the significance of morphological and structural characters, their degree of variation, and their cause. We have had enough of these studies of single things without bearings or relations, made by candidates for a degree whose botanical work is sure to end with the theses that they have been able to produce with the bolstering aid of their instructor, studies that mean nothing because the workers failed to grasp the real purpose of the study and its true relations and bearing on the general subject. It is too late to accept candidates for degrees in botany, who seek the degree as an ignominious end rather than a well-earned beginning and preparation for future work along botanical lines. Whatever we may be obliged to do with and for those who take undergraduate work in botany because they have to, we have no time for graduate triflers or any who are not intent on making botany their life work—who study botany not because it is a present fad or because they really think they have to study something, but because they are botanists born and must become botanists trained. Such will find their thesis the beginning of a series of researches instead of the swan song of a neophyte. In order to limit a wide subject more closely and continue our consideration of fields opening up to the trained botanical student, we may turn in particular to the field of work that lies open to the systematic botanist in America. For the higher plants I can do no better than to quote a recent remark of my successor in office, whose personal studies give to his opinion far greater weight than any words of mine, that there is scarcely a large genus represented in

America that is not in real need of revision, and surely the unparalleled activity of recent workers in this field not alone in the west and south, where novelties were more naturally to be expected, but even in New England and other parts of the Northeast, would seem fully to justify the assertion. Intelligent field study of which we need much more by trained botanists rather than by untrained field collectors is yielding its natural and legitimate fruit. And long before our ecologists can attain definite point to their labors we must know with far greater precision than now the definite limitation of the species of our higher flora.

When we turn to the lower plants we find a still more virgin field in which to sound the call for able workers; here not only is the need of revision real, but it is crying and in some cases almost shrieking in its need. Among the fungi the desultory description of species 'supposed to be new' must give way to careful revision, genus by genus and family by family. Field work and culture methods must supplement the most searching comparative study of the widest accessible array of material, and while it will certainly result in great reductions of species carelessly described by the older methods and in the correction of many errors of over-hasty reference of American species to those of European origin, it will also result in bringing to light many that by the same methods have been entirely overlooked. We could at once place twenty men carefully trained for research at work on as many groups of fungi in which our definite knowledge is only a hazy mass of crude and scattered bits of information needing to be brought into harmony with the results of careful consecutive comparative study. And beyond matter of the definite limitation of the species within the genus and the genus within the family, there are beyond and more far reaching in their scope the most important questions

of alliances and origin of groups that demand the highest efforts of the most careful workers.

Among the Algæ the conditions are still worse, particularly among many fresh water forms, for here not only are our species in a haze of uncertain definition, but the very characters to be used in specific definition in many groups still remain to be formulated.

To accomplish this systematic study of our flora successfully will require the active co-operation of field botanists and special students. No longer can one man or a few men seek to realize the complete definition of even the higher flora much less the lower. There must be the most complete and candid co-operation on every hand. To this end we offer a few suggestions.

1. More and more the real systematic study of our flora must proceed from the centers where are gathered the stores of material and among these centers there ought to be the freest possible interchange of courtesies. Isolated workers in the field whose training is such that their judgment regarding specific limitation is worthy of respect, before attempting to publish their results should supplement their field and home study by an occasional year or at the very least frequent long vacations at some one of the centers where contact with books and types and still more with other workers and methods would correct their results and stimulate to better effort.

2. More and more the local field workers and amateurs should realize that as isolated facts are worthless until brought into harmony with some general law, so material illustrating the distribution and variation of certain plants is only valuable when deposited where it is accessible to botanical workers generally. Great collections are only good as well as great when the material they contain is accessible to those who are trained to study it, and local col-



lectors ought to realize that by freely supplying the material within their reach they confer a favor not so much to the particular center that receives it as upon all future workers in that field who look to that center as the proper repository of the material they need to carry on their researches. The most obscure field collector by concentration of observation rather than by diffusion of effort may add material that will be of vital importance to a correct and complete knowledge of our flora. More and more these field workers must be content to wait for results and not be clamorous for their material to be named by the next mail, resting assured that the material they contribute will receive due recognition on the final results and that none of their work that is really useful will go to waste; on the other hand the specialist taking his material in order will gain time for his final revision that would otherwise be badly broken up in miscellaneous examinations and too often marred by hasty determinations and conclusions.

The different attitude of people toward the botanist and toward certain of the scientific workers in fields where there is a much more decided commercial phase to the science, resulting in part from the fact that real botanists are such because they are first lovers of their subject, is well illustrated in this matter of the freedom with which material is sent to botanists for examination and report. Fancy a man sending to a well known chemist a half dozen samples of water for chemical analysis with the assurance that if any of the water is not used up in the process, the chemist may have it for his trouble!! And yet no one thinks of anything else in sending a botanist from a half dozen to two hundred specimens in a bale with the information that he would like them named and the specimens need not be returned. To do this correctly involves skill that requires fully as great an amount

of scientific preparation and often more expenditure of time than to make a similar number of water analyses, yet to the botanist the idea of pay has not been presented. While it is true that by this self-sacrifice many of our great collections have been enriched with valuable material, and many solitary workers have been encouraged to better things, it is also true that it has been accomplished with an immense waste of time and nervous energy that ought not to be too lightly demanded of active workers. And this labor is all the more exasperating when some botanical worker who does not appreciate the necessity of abundance of good material brings in from some distant region merely a series of odds and ends of fragments that are yet sufficient to show that something really worth having might have been collected by a little expenditure of common sense and foresight on the part of the collector.

3. There are some practices rife even among those from whom we naturally expect better things which ought in some way to be put under the ban. I need only mention the practice of literary revisions of genera with no commensurate study or even knowledge of the plants themselves; the so called galvanic method of transferring species heterogeneously from one generic group to another except in definite monographic work; and the description of species in check-lists, fly-leaves, circulars, and other out-of-the-way places where they are not readily accessible to the general botanist. In short the closing years of the nineteenth century ought to sound the death knell of the literary enthusiast and the galvanizer and mark the disappearance of the grotesque and the rafinesque from American botany.

4. The extent of territory covered by the American Flora is on the eve of a remarkable expansion. The political events of the past few years are in part responsible for

this, but for years it has been evident that it was only a question of a little time when such expressions as 'a revision of the species north of Mexico' should be obsolete in American botany. The extensive explorations of Mexico and Central America by Anglo-Saxon American explorers have resulted in placing the flora of those countries in the hands of American botanists, and the Spanish War has had among its other results the transfer of the flora of the Antilles to the same hands. And with the extensive explorations that in recent years have been made by our botanists in South America, I fail to read the signs of the times correctly if they do not point to the ultimate inclusion of all the American continent from Alaska to the Straits of Magellan in the future of American systematic botany. Scarcely anything can be expected of our neighbors in the Central and South American States and many Europeans overlooking American work already accomplished or wilfully ignorant of it, are too often unsatisfactory in their results; surely it is at once the privilege and the duty of the botanists of this country to take the initiative in a vastly more extended and systematically organized way than has ever been attempted and solve the most important problem that remains in the study of phyto-geography; the flora of the darkest of all dark continents—South America. Explorations on a stupendous scale, such as are necessary to attack this problem, can best be organized here in America where the accomplishment of great things is no longer a novelty. The English already realize that they have problems sufficient on their own hemisphere fully to engage their attention; and it will not be long before our German friends will realize the same situation. It is most natural that Americans who are more familiar with conditions here and are more at home with the flora of the upper portions of the American con-

continent, should be the ones to undertake this work and it is most certain that they will carry it out with greater accuracy because of their ability and proximity. I think it behooves the Americans practically to withdraw from any except the necessary comparative study of the flora of any part of the Eastern Hemisphere, and combine with such division of labor as will be practical and equable on the study of the flora of the American continent. In this way by example at least we can show our friends across the sea that in botany at least the Monroe doctrine is still a living and practical issue. I might add that those who are hoping for an international congress originating in Europe to settle questions of nomenclature, or any other line of botanical policy or procedure, entirely misunderstand the tenor of European methods, or the genius of European conservatism and inertia; such as wait for a European congress to settle anything, will wait until their descendants of the third generation are tottering with age before such an adjustment will really occur. Americans must take the initiative in all these matters if they are ever to be settled, and the Old World must follow the lead of America in every field where progress is involved.

But all this extension of the study of our flora, even that which is limited to the North American continent, means years of study that cannot be accomplished on this side of the water. We are debtors to the Old World in that they found our continent and with that discovery took back to their own the memorials of their conquest. Not only are the great herbaria at Kew, at the British Museum, at Berlin, and at Paris the repositories of the types of many of the species of the American tropics but in these great collections are what are often more valuable than the types themselves, namely extensive suites of plants illustrating better than the type itself the range and varia-

tion and allies of the tropical species. To these greater collections we should add the lesser at Copenhagen, Geneva, Vienna, Prag, St. Petersburg and Madrid, all of which must be visited again and again before we can fully define even our North American tropical flora. To this end it will be in order to look to the establishment of traveling fellowships that will make possible continued study in those European storehouses by trained American specialists.

The time has come for American Botany to assert itself in the modest way that becomes Americans, and assume its true position in the work of botany in the world. We have the men who have profited from the training of the best the Old World could produce in morphological, physiological, and cytological work among plants; we have young men trained and in training who have the mental acumen of the best any country can produce, combined with a degree of practicality, vitality and energy of which very many of the Europeans are lacking; we have men of means who are philanthropic toward botanical research and stand willing to aid in every work that merits recognition, and if we in America do not in the next quarter of a century lead the world in matters botanical, it will be because we are not true to the instincts that guided the fathers in botany and because we do not enter into our heritage and magnify our opportunities.

LUCIEN M. UNDERWOOD.

COLUMBIA UNIVERSITY.

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ARTIFICIAL PARTHENOGENESIS IN AN-  
NELIDS (*Chaetopterus*).

My experiments on the artificial parthenogenesis in sea-urchins have led me to the following results: (1) Through a certain increase in the osmotic pressure of the surrounding solution, the unfertilized eggs of

some (probably all) Echinoderms can be caused to develop into normal blastulæ or plutei. (2) This increase in osmotic pressure can be produced by electrolytes as well as by non-conductors. It is therefore probable that the parthenogenetic development is caused by the egg losing a certain amount of water.\*

I considered it necessary to try whether the same results can be obtained in other groups of animals by the same means. I have recently succeeded in producing artificial parthenogenesis not only in starfish (*Asterias*), but also in worms (*Chaetopterus*). The experiments on the artificial parthenogenesis in Annelids led to the unexpected result, that the unfertilized eggs can be caused to develop into apparently normal larvæ (*Trochophores*) by two entirely different methods: First, by increasing the concentration of the surrounding solution (osmotic fertilization). This method is qualitatively the same as the one by which I produced plutei from the unfertilized eggs of Echinoderms. Second, by changing the constitution of the sea-water without raising its concentration (chemical fertilization). Through a slight increase in the amount of K-ions in the sea-water the eggs of *Chaetopterus* can be caused not only to throw out the polar bodies as Mead had already observed, but also to reach the *Trochophore*-stage and swim about as actively as the larvæ originating from fertilized eggs. Further experiments showed that the K-ions have no such specific effect upon the unfertilized eggs of Echinoderms. This fact may help us to understand why a hybridization between worms and Echinoderms is impossible. I shall publish a full report of these experiments in one of the next numbers of *The American Journal of Physiology*.

JACQUES LOEB.

WOODS HOLL, July 22, 1900.

\* Loeb, J., *The American Journal of Physiology*, Vol. IV., August, 1900.